DETAILS OF THE WEATHER OF THE MONTH IN THE UNITED STATES.

CYCLONES AND ANTICYCLONES.

By A. J. HENRY.

Cyclones.—Practically all of the cyclones of the month first appeared in the daily Weather Maps off the coast of British Columbia and either moved thence eastward along the northern circuit or secondaries were developed over the plateau region and later crossed the mountains and advanced eastward in the form of NE.–SW. troughs of low pressure. High pressure, which prevailed over the Great Basin from the 13th until the close of the month, seemed to retard and, in some cases, to prevent the eastward movement of cyclones that appeared off the Washington coast. From the 1st to the 13th, secondary cyclones passed across the mountains south of Wyoming. After the 13th the movement was more directly eastward along the northern circuit. None of the cyclones was of pronounced type except that one which moved in from the Pacific on the 10th at a time when the surface was snow-covered, although surface temperature west of the divide on this date was above freezing; east of the divide the temperature was considerably below zero and there was a strong temperature-pressure gradient extending SE.–NW. across Wyoming, southwestern Montana, and eastern Idaho. The Weather Maps of the 11th and 12th are typical of the surface conditions under which a well-developed cyclone crosses the Rocky Mountains in the winter season. The motion from the Pacific is southeastward until the Great Plains of Colorado and Kansas are reached, thence northeast to the Lake region. It is worthy of note that the deep cyclone over southern Idaho on the 11th was immediately followed by a strong anticyclone which persisted in that region until the close of the month, as mentioned in the next paragraph.

Anticyclones.—The weather was distinctly under anticyclonic control the greater part of the month. A strong anticyclone moved from the northern Rocky Mountain region on the 1st to the middle Atlantic coast by the 4th. This was followed by two others, with a cyclone intervening between each of them. The pronounced cyclone of the 10th was followed by a strong anticyclone which had become firmly established over southern Idaho on the morning of the 13th. It remained practically stationary with undiminished intensity during the 14th–16th. Then pressure fell somewhat in its northwestern quadrant, thus automatically shifting the center of highest pressure to western Colorado, where it remained from the 20th to 25th. On the 26th, pressure having risen over Idaho and Nevada, the center was again established over southern Idaho, where it remained until about the close of the month. The winter-pressure distribution thus described, so long as it continues, seems to have an important bearing upon the weather of the United States as a whole. Some of the associated conditions are as follows: Generally dry weather with frost in California away from the coast; Chinook winds east of the mountains in Idaho and western Montana; frequent alternations of high and low temperature east of the Mississippi and north of the Ohio but no severe cold.

THE WEATHER ELEMENTS.

By P. C. DAY, Climatologist and Chief of Division.

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PRESSURE AND WINDS.

At the beginning of the month high pressure was advancing from the British northwest, and severe cold for the season had overspread most northern and central districts. The high area extended into the more eastern districts, and by the middle of the first decade had passed off the middle Atlantic coast. In the meantime there was a general reduction in pressure over northern and far western districts, but elsewhere the pressure still continued above normal.

During the latter half of the first decade pressure diminished over the South, and storm areas, forming over the Southwest, moved easterly, causing rain or snow over large areas. Toward the close of the decade, however, high pressure again moved into the Northwest and by the close it had advanced into the middle Mississippi Valley, where the sea-level values were nearly 31 inches, the highest ever observed in December at several points. In much of the West the coldest weather of the month was observed, about this time, the minimum temperatures over the Great Plains and Rocky Mountain regions on the morning of the 9th ranging from 30° to nearly 50° below zero (F.).

While this high area was advancing toward the Atlantic coast, there was a sharp reaction to lower pressure in the far West, which likewise moved eastward reaching the Atlantic coast about the middle of the second decade. In the far West, however, there was a quick return to above normal pressure and by the morning of the 14th sea-level pressure was near 31 inches in the northern plateau, the reading at Boise, Idaho, 30.96 inches, being the highest ever observed at that place. In connection with this high pressure, severe cold prevailed in the far Northwest, the minimum temperature falling to 50° or more below zero (F.) at exposed points in Idaho and Montana. The lowest temperatures ever observed in December occurred during this period at numerous places, and at some points they were the lowest observed in any winter month. High pressure and severe cold continued throughout most central and western districts until after the middle of the second decade; and in portions of the plateau, pressure remained high and severe cold continued until the end.

During the third decade of the month, lower pressure was the rule in practically all parts of the country, although a high area of moderate intensity was maintained over the plateau region during the greater part of the decade, assuming considerable proportions at times, but confined in the main to districts west of the Rocky Mountains, until the end of the month when it shifted to the Missouri Valley and colder weather had again overspread the Northwest. In the central and southern portions of the country pressure was generally falling at the close of the month, with the lowest barometer readings over the middle Mississippi Valley.

The average pressure for the month (Chart VII and Tables I and III) was above normal over the entire country, and in Canada as well, as far as available observations disclose. In portions of the Rocky Mountains and plateau region the pressure averaged decidedly higher than normal and this persisted to some extent over the Canadian northwest and generally over the central and northern portions of the interior valleys. The excess was least over the South Atlantic and East Gulf States and along the central and south Pacific coast, where the averages were usually only slightly above normal.

The winds were usually moderate in character, and high velocities were confined mostly to coast disctricts, particularly at exposed points along the middle and north Pacific coast sections, where high winds are usual at this period of the year, and along the Atlantic coast from New York to Nantucket, where about the 10th and 11th and again on the 15th some high winds occurred. Over much of the country to eastward of the Rocky Mountains the winds were mainly between northerly and westerly points, although in portions of the Lake region and Ohio Valley there was a strong tendency toward southwest winds. In the far Northwest there was a considerable tendency to easterly winds due to diminishing pressure toward the Pacific coast.

TEMPERATURE.

December, 1919, was a month of almost continued cold over the greater part of the country, but particularly so in the central and northern mountain and plateau districts, where in some cases the temperature was below normal nearly the entire month. At Grand Junction, in western Colorado, the daily means were continuously below normal, usually to a large degree, except on three dates when there were slight excesses, the average for the month being the lowest ever reported in December, at that place. At Walla Walla, in southeastern Washington, the mean daily temperatures were continuously below normal during the first two decades of the month. The departures from the normal for the 15-day period, December 2–16, inclusive, averaging more than 30° (F.) per day, and during the 5-day period, from the 11th to 15th inclusive, the average departure was −40° (F.) per day. Severe cold set in over that district about November 25 and, continuing without material interruption until the end of the second decade in December, comprised a period of the most severe and long-continued cold in the known history of that section.

The period from about the 8th to 13th was probably one of the longest with continued severe cold ever experienced in the far Northwest. At Rapid City, in western South Dakota, the temperature was continuously below zero for more than five days, and on the extreme northern coast of Washington, despite the surrounding ocean warmth, the temperature at Tatoosh Island, remained below freezing for the same period, a record not previously observed at that place.

Farther east, over the Northern Plateau States, there was a considerable moderation in temperature during the latter half of the month, but here severe cold had been almost continuous since the early part of October, and while the current month as a whole was not so cold as in some previous years, the period October 9 to December 16 was on the whole one of the coldest ever known. At Williston, N. Dak., the daily temperatures during that period, 69 days, averaged more than 14° F. per day below normal.

In general the coldest period of the month was from the 9th to 15th, when minimum temperatures ranged from 24° F. above zero in northern Florida to 52° F. below zero in Montana. In portions of the Ohio Valley, and from Virginia northward to New England, the coldest period was about the close of the second decade.

The highest temperatures for the month were generally observed near the end, although over the Southern States, from Texas eastward, the warmest period was during the latter part of the first decade. Along the South Atlantic coast and in portions of Florida the maximum temperatures on the 8th and 9th were at numerous points the highest ever observed in December. At the same time the lowest temperatures ever observed were being experienced in the Rocky Mountain region. At points in southern California the maximum temperatures on the 28th were in excess of any previously experienced in that section in December.

For the month as a whole, the temperature averaged below normal in nearly all portions of the country. In a few cases, particularly in the northern districts from the Mississippi Valley eastward, the month was as a whole colder than December, 1917. At a few points in the far Northwest it was likewise the coldest December of record. Over the Southern States to eastward of Texas the month, as a whole, was slightly warmer than the average, and there was a small area in the far Southwest with similar conditions.

PRECIPITATION.

The month was notably free from well-developed storms and attendant wide areas of precipitation usual to a winter month.

The principal storm periods of the month occurred during the latter half of the first decade. The first moved from the southern Plains region to New England during the 6th and 7th, accompanied by very general though moderately light precipitation over most districts from the Great Plains eastward. The second and principal storm of the month moved rapidly from the far Southwest during the 8th, and by the morning of the 9th was central in the Ohio Valley from whence it moved during the following 24 hours to the lower St. Lawrence Valley. This storm brought more or less precipitation to nearly all parts of the country, snow over the northern and rain in the central and southern districts. In portions of the Middle Gulf States the precipitation was markedly heavy, particularly in eastern Mississippi, the greater part of Alabama, and over much of western Georgia. In some cases the falls from the 7th to the 9th ranged from 10 to 12 inches, the 24-hour amounts frequently ranging from 5 to 7 inches or more. These heavy rains caused some of the worst floods ever known in the regions referred to, with heavy property damage and some loss of life. Considerable precipitation occurred over the more eastern districts during the 13th and 14th, but from that period until the end of the month only light local precipitation occurred in any part of the country, in fact the last half of the month was remarkably free from stormy weather of any sort for a winter month.

For the month as a whole precipitation was below normal in nearly all parts of the country, and in portions of the South Atlantic States the drought that has persisted for several months still remained unbroken at the end of the year. At Savannah, Ga., and Charleston, S. C., the amounts for the month, with one exception, were the least for December in nearly 50 years. Over a small area in the Middle Gulf States, notably in Alabama and the adjoining portions of Mississippi and Georgia, the heavy

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precipitation during the latter part of the first decade exceeded largely the normal for the entire month, and small excesses occurred in portions of South Carolina, Kentucky, and West Virginia, and similar conditions prevailed in portions of Wyoming and Montana.

SNOWFALL.

For a winter month December, 1919, had, as a rule, much less snow than usually falls. A few limited areas had unusually large amounts for single storms but, for the month as a whole, the total depths were nearly everywhere unusually small.

At local points in the Middle Plateau, the snowfall during the first few days of the month was unusually heavy for that region and, due to continued cold, remained on the ground for a considerable period. Likewise on the 9th and 10th a heavy fall of snow occurred over nearly all portions of the far Northwest. In portions of Oregon, Washington, and Idaho, the depths at the lower elevations were the greatest ever reported for a single storm; and on account of the severe cold existing at the time, it remained on the ground for a much longer period than usual. In the upper Michigan Peninsula the snowfall, though usually light for individual falls, nevertheless amounted in places to over 4 feet for the entire month.

At the end of November a larger part of the country than usual was snow-covered, the depths being particularly large for so early in the winter over the northern districts from the Great Lakes westward and generally in the mountain regions of the West. On account of the frozen condition of this snow, owing to severe cold, it remained on the ground unmelted for long periods, particularly in the Northern Plains, and mountain districts and much suffering to stock resulted from inability to secure the food usually available on the ranges and the frequent lack of any provisions for feeding in other ways so early in the winter.

RELATIVE HUMIDITY.

Wide variations in the relative humidity values for near-by stations are shown when compared with the normal, some of which are doubtless due to the difficulty experienced in securing accurate data at low temperatures. As a whole, however, the relative humidity was above the normal for December over the greater part of the country, marked exceptions occurring, however, over the southeastern and far northwestern districts, where the values were in some cases decidedly below normal.

SEVERE STORMS.

The occurrence of a tornado was reported at Marion, Miss., at 3:18 p. m., December 7. Considerable property damage was sustained and one person was killed.

Winds of 50 mi./hr. (22.4 m./sec.) or more during December, 1919.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Block Island, R. I.	10	60	nw.	North Head, Wash.	19	62	s.
Do.	15	58	nw.	Do.	20	64	s.
Buffalo, N. Y.	10	54	w.	Do.	22	70	s.
Do.	13	54	sw.	Do.	23	58	se.
Do.	15	57	w.	Do.	24	62	s.
Do.	26	58	sw.	Pittsburgh, Pa.	30	53	nw.
Burlington, Vt.	10	52	nw.	Pocatello, Idaho	11	50	s.
Do.	12	52	s.	Do.	12	52	sw.
Cheyenne, Wyo.	9	52	w.	Point Reyes Light, Calif.	4	85	s.
Do.	10	54	w.	Do.	5	59	se.
Do.	14	60	w.	Do.	7	58	nw.
Do.	15	50	w.	Do.	8	65	nw.
Duluth, Minn.	29	51	nw.	Do.	9	56	s.
Ellendale, N. Dak.	25	50	nw.	Do.	10	63	s.
Erie, Pa.	11	50	se.	Do.	11	54	sw.
Lander, Wyo.	10	56	sw.	Providence, R. I.	10	66	nw.
Mount Tamalpais, Calif.	4	66	se.	St. Louis, Mo.	12	51	sw.
Do.	5	52	se.	Sandy Hook, N. J.	10	52	nw.
Do.	7	60	nw.	Tatoosh Island, Wash.	1	56	ne.
Do.	8	58	nw.	Do.	2	51	e.
Do.	9	50	se.	Do.	9	70	ne.
Do.	10	58	s.	Do.	10	62	ne.
Do.	11	52	sw.	Do.	18	59	s.
Nantucket, Mass.	25	52	ne.	Do.	19	52	e.
New York, N. Y.	10	72	nw.	Do.	20	62	s.
Do.	15	50	w.	Do.	22	59	s.
Do.	17	52	nw.	Do.	23	55	s.
North Head, Wash.	16	68	s.	Do.	26	54	s.
Do.	17	62	se.				

Average accumulated departures for December, 1919.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	° F.	° F.	° F.	In.	In.	In.	0-10		P. ct.	
New England	24.6	− 4.5	+12.5	2.18	−1.20	+ 1.11	6.5	+0.3	76	0
Middle Atlantic	31.6	− 3.7	+22.7	2.43	−0.80	− 3.70	6.6	+0.8	74	−1
South Atlantic	47.0	− 0.2	+21.7	1.86	−1.00	− 9.50	5.2	+0.3	75	−2
Florida Peninsula	67.9	+ 1.5	+ 5.0	1.45	−0.60	+ 3.60	4.2	−0.4	77	−5
East Gulf	50.2	+ 1.1	+16.1	6.95	+2.40	+11.86	5.3	−0.2	76	−1
West Gulf	47.8	− 1.2	− 3.2	1.35	−1.50	+ 8.95	6.3	+1.1	72	−2
Ohio Valley and Tennessee	32.3	− 4.3	+16.1	3.46	00	+ 3.40	6.5	+0.1	77	° 0
Lower Lakes	23.2	− 6.0	+16.4	1.44	−1.40	− 1.10	7.3	−0.5	75	−4
Upper Lakes	16.2	− 8.3	+21.5	1.31	−0.80	− 2.20	7.5	+0.2	82	0
North Dakota	8.4	− 3.4	+ 8.3	0.42	−0.20	− 2.35	5.0	−0.6	89	+5
Upper Mississippi Valley	19.1	− 8.1	+13.6	0.72	−1.10	+ 2.00	6.9	+0.9	82	+3
Missouri Valley	22.2	− 4.6	+13.6	0.34	−0.70	− 2.20	5.5	+0.2	83	+7
Northern slope	18.4	− 5.2	+ 5.9	0.78	−0.10	− 1.80	4.6	−0.7	74	+1
Middle slope	30.0	− 3.2	+ 2.6	0.27	−0.50	− 3.83	3.8	−0.4	74	+6
Southern slope	42.4	− 1.3	−12.3	0.32	−0.50	+ 0.10	4.7	+0.2	66	−2
Southern Plateau	40.9	+ 1.6	+ 6.8	0.31	−0.40	+ 1.19	2.9	−0.3	57	+6
Middle Plateau	25.0	− 6.3	− 1.9	1.13	+0.20	− 2.20	4.3	−0.8	75	+3
Northern Plateau	21.8	−10.2	− 2.3	1.54	−0.20	− 2.30	6.9	00	82	+2
North Pacific	38.5	− 3.6	+ 3.1	5.32	−2.40	− 9.60	6.7	−1.1	81	−6
Middle Pacific	46.6	− 2.0	− 9.2	3.24	−1.20	− 6.30	5.9	+0.4	78	−1
South Pacific	53.9	+ 1.0	+ 5.1	1.97	−0.20	− 4.90	3.8	−0.5	67	−1